AP Statistics
Test: The Normal Distribution
Instructor's Version

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Answers: Free Response: 3 questions, 52 points, 30 minutes

1. **The following are two sets of class scores (you may consider these scores to be normally distributed). Julia received the two scores marked with an asterisk. Did she do better or worse on the second test? Why?** (16 points)

First Test	48	*56	61	60	39	49	5	57	52	51	
Second Test	75	81	63	*74	59	88	77	79	76	69	67

Answer:

First Test: $\bar{x} = 47.8,\ s = 16.376,\ z_{56} = \frac{56 - 47.8}{16.376} = .501$

Second Test: $\bar{x} = 73.45,\ s = 8.37,\ z_{74} = \frac{74 - 73.45}{8.37} = .066$

Julia did worse on the second test because her *z*-score shows that she was closer to the mean than she was on the first test.

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Scoring Notes: *16 points for this question*
6 points for correct mechanics for the first test.
6 points for the correct mechanics for the second test,
4 points for the correct interpretation of the mechanics done for the two tests. No credit unless they compare standardized scores (they can't just argue intuitively from the numbers; they must do some statistics!)

2. Use the *empirical rule (68-95-99.7)* to determine if the following maximum daily rainfall totals could be considered to be normally distributed. (16 points)

1.1, 1.2, 1.5, 1.55, 1.71, 1.75, 1.9, 1.94, 1.99, 2.0, 2.05, 2.08, 2.12, 2.18, 2.2, 2.25, 2.36, 2.5, 2.61, 2.81, 2.88, 2.95, 3.0, 3.03, 3.07, 3.16, 3.25, 3.62. (Note: they are already in order!)

Answer:
The mean of this data set is 2.31 and the sample standard deviation is .647. Therefore, by the empirical rule, you would expect to find approximately 68% of the terms within one standard deviation of the mean (2.31 ± .647 = <1.66,2.96>), 95% within two standard deviations of the mean (2.31 ± 2(.647) = <1.02,3.60>), and 99.7% within 3 standard deviations of the mean (2.31 ± 3(.647) = <.37,4.25>). Since the data are already ordered, you can easily count the number within one, two, and three standard deviations of the mean.

/// // 1.1, 1.2, 1.5, 1.55, /1.71, 1.75, 1.9, 1.94, 1.99, 2.0, 2.05, 2.08, 2.12, 2.18, 2.2, 2.25, 2.36, 2.5, 2.61, 2.81, 2.88, 2.95/, 3.0, 3.03, 3.07, 3.16, 3.25, //3.62///

There are 18/28, or 64%, within one standard deviation, 27/28, or 96%, within 2 standard deviations, and 28/28, or 100%, within 3 standard deviations; 64-96-100 is close enough to 68-95-99.7 for us to agree that the data plausibly are normal.

Scoring: *16 points for the question.*
4 points for computation of the correct mean and standard deviation.
4 points for using their mean and standard deviation to determine the intervals for the 68-95-99.7 rule.
4 points for determining how many are in each interval.
4 points for correctly interpreting their counts.
Note: *They could make an error in computing their mean and standard deviation, but they would still be eligible for the remaining 6 points if they followed through correctly.*

3. Ten thousand adults were given a literacy test. The results were nearly normally distributed (μ = 75, δ = 15). (20 points)

A. About how many scored between 60 and 80? (8 points)

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Answer:
Using a TI-83: normalcdf(60,80,75,15) = .4719.
Using tables: $z_{80} = \frac{80-75}{15} = .33 \Rightarrow A_1 = .6293$, $z_{60} = \frac{60-75}{15} = -1 \Rightarrow A_2 = .1587$,
$A_2 - A_1 = .6293 - .1587 = .4706$
Note: there is a slight difference in accuracy due to rounding.

> ***Scoring:*** *for part (A): 8 points for showing process and correct answer. "normalcdf" is sufficient for process. Max. of 4 points for correct answer alone with no explanation.*

B. What score did only the top 15% exceed? (6 points)

Answer:
There are 15 % of the scores above the X value we're looking for, so 85 % of the scores are below this *X*. $A = .85 \Rightarrow z_X = 1.04 = \frac{x-75}{15} \Rightarrow X = 90.6$.

> ***Scoring*** *for part (B): 2 points for correct answer. 4 points for explanation leading to answer (complete explanation = 3; partially complete explanation = 2). Correct explanation with wrong answer is worth 3 points unless it is clear that a minor arithmetic error has been made – then 5 points are possible even though the answer is incorrect.*

C. Find the percentile rank of the person who scored 88. (6 points)

Answer:
$z_{88} = \frac{88-75}{15} = .87 \Rightarrow A = .8078$. Hence the percentile rank of 88 was approximately 81.

> ***Scoring*** *for part (C): 3 points for arriving at the correct area. 3 points for interpreting the area correctly as a percentile. The student is still eligible for additional points with an answer that is correct for an incorrect area.*

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